

## POTENTIAL FOR CULTURE OF GREY MULLET (PISCES:MUGILIDAE) IN GHANA

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### Abstract

The potential for culture of grey mullets in Ghana was investigated in fresh and brackish water ponds. Growth performance of fish that were given supplementary feed was better than those cultured without supplementary feeding. However, the difference in growth was not significant. The difference between the growth of fish raised in fresh water and that of those raised in brackish water ponds was also not significant. Feed conversion ratio of 6.0 was recorded in fresh and brackish water ponds while survival rates ranged from 43.4 to 68.8 per cent in the various ponds. Within a 270-day culture period, fish production of 336.5 and 287.0 kg ha<sup>-1</sup> were recorded in ponds with and without feed, respectively. The mean final weight of *Mugil curema* (Valenciennes) was the highest among the species cultured. The results for this study compared favourably with other published works and indicated a good potential for the culture of grey mullets in Ghana.

### Introduction

Fish culture has been identified worldwide as an important option for increasing fish production (Bardach, Ryther & McLarney, 1972). However, efforts at increasing fish production in Ghana through fish culture so far have concentrated on fresh water environments, although the coastline of the country has numerous lagoons and estuaries most of which have the potential for

### Résumé

DANKWA, H. R., BLAY, J. JR & YANKSON, K.: *Potentiel pour l'élevage de mulets (Pisces: Mugilidae) au Ghana*. Le potentiel pour l'élevage de mulets au Ghana était enquêté dans les viviers de l'eau fraîche et de l'eau saumâtre. Le résultat de croissance des poissons qui étaient nourris de ration supplémentaire était meilleur que ceux qui étaient élevés sans alimentation supplémentaire, mais la différence en croissance n'était pas considérable. Aussi, il n'y avait pas de différence considérable entre la croissance des poissons élevés dans l'eau fraîche et ceux élevés dans les viviers de l'eau saumâtre. Une proportions de conversion de ration de 6.0 était enregistrée dans les viviers de l'eau fraîche et de l'eau saumâtre alors que les proportions de survie variaient de 43.4 à 68.8 pour cent dans les viviers divers. Dans une période de 270 jours de pisciculture, la reproduction de poisson de 336.5 et 287.0 kg ha<sup>-1</sup> étaient réalisées respectivement dans les viviers avec ration et sans ration. Le poids final moyen de *Mugil curema* (Valenciennes) était le plus élevé des espèces élevées. Les résultats obtenus dans cette étude se comparent favorablement avec d'autres oeuvres publiées et indiquent un bon potentiel pour l'élevage de mulets au Ghana.

brackish water fish culture (Pillay, 1962; Pauly, 1976). A traditional form of brush-park fish culture system, known as 'acadja', is practised on a small scale in some lagoons (Mensah, 1979). The impact of fish culture on the total fish output of Ghana is negligible. As at 1999, fish culture contributed just about 500 tonnes out of the national fish production of about 400,000 tonnes a year (Fishery Dept., unpublished data).

In Ghana, grey mullets are important in the lagoon, estuarine and inshore fisheries (Mensah, 1979). The culture of mullets in brackish and fresh water ponds has been practised for many years in many countries, especially in the Indo-Pacific region and Mediterranean countries (Yashouv, 1966, 1972; Bardach *et al.*, 1972; ICLARM Report, 1980; Pillai *et al.*, 1984; Philips *et al.*, 1987). Mulletts now form an important component of intensive and extensive fisheries of these countries. The culture of grey mullets has not been well developed in West Africa, and published work on their culture has been lacking in Ghana. However, a few culture trials have been conducted in Côte d'Ivoire (Albaret & Legendre, 1985) and in the Niger River delta in Nigeria (Sivalingam, 1975).

This study aimed at evaluating the potential of grey mullets for culture in brackish and fresh water systems in Ghana. Apparently, from the experiences of other countries, successful intensive and extensive culture of grey mullets in Ghana could enhance fish production and help bridge the gap between dwindling supply and increasing demand.

### Experimental

Four brackish and fresh water earthen ponds were used for mullet culture trials. Each fresh water pond measured 5.0 m × 10.0 m × 1.0 m, and were at the Aquaculture Research and Development Center (ARDEC) of the CSIR-Water Research Institute (WRI), Akosombo (about 160 km from the River Volta estuary). The brackish water ponds were about 400 m from the mouth of the River Volta estuary. They measured 5.7 m × 14.0 m × 0.8 m, 5.4 m × 14.0 m × 0.8 m, 5.4 m × 14.0 m × 0.8 m, and 5.4 m × 11.5 m × 0.8 m.

Fingerlings of grey mullet species were collected from the Volta river estuary with a drag net of mesh size (stretched) 15.0 mm at the wings and 10.0 mm at the pocket. They were kept overnight in hapas erected in ponds to condition them and then transported to Akosombo in plastic bags. On arrival, the fingerlings were acclimatised

to brackish water conditions that had been simulated with common salt (NaCl) in concrete tanks before they were released. Salinity in the tanks was progressively reduced daily till fresh water conditions prevailed by the 7th day. The fingerlings were then stocked into earthen fresh water ponds at a density of 2 fingerlings m<sup>-2</sup>. Mixed species were stocked in fresh and brackish water ponds because of the difficulty in sorting out the species at that size.

Fish in two ponds at both places (i.e., brackish and fresh water culture) were fed once daily in the morning between 09.30 and 10.00 h at 5 per cent body weight. The feed consisted of a mixture of peanut and rice bran, giving a protein level of 9 per cent. Fish in each of the remaining ponds were not fed, but depended on the natural productivity of the ponds. The ponds were occasionally fertilised with super phosphate at 10 g m<sup>-2</sup> and limed at 100 g m<sup>-2</sup>. Water temperature, salinity, dissolved oxygen, pH, turbidity, and transparency were measured biweekly between 10.00 and 11.00 h.

A minimum of 50 fish from each pond was sampled at 30-day intervals. The average weight recorded was used to monitor growth and to determine the specific growth rate (SGR), using the formula of Ricker (1975) (quoted in Watanabe *et al.*, 1990):

$$SGR = [100 (\ln W_f - \ln W_i)] / t$$

where  $W_f$  = mean weight at the end of the period,  
 $W_i$  = mean weight at the beginning of the period, and

$t$  = growth period in days.

The mean daily weight gain (MDWG, g/day) was calculated from:

$$MDWG = (W_f - W_i) / t$$

The Student's t-test was used to evaluate differences in growth performance of fish raised in brackish and fresh water ponds for the first 180 days. Feed conversion values were determined as the ratio of dry weight (g) of feed given to the fish to the weight gained (g) by the fish at the end of the experiment (Linder, Strawn

& Luebke, 1975). Fish production in the ponds was calculated using the formula of Linder *et al.* (1975):

$$\text{Production} = \text{Number of fish surviving} \times (\text{Mean final weight} - \text{Mean initial weight}) / \text{Surface area of pond.}$$

Survival rate of mullets in each pond was calculated as a percentage of the number of mullets surviving at the end of the experiment to the number of mullets initially stocked. Culture trial in fresh water ponds was prematurely terminated after 180 days owing to heavy predation while that in brackish water ponds was continued for 270 days.

## Results

### *Culture trials in brackish water ponds*

The mean values of water quality parameters for both treatments (i.e., with and without feed) indicate that the difference between treatments was not significant ( $P > 0.05$ ) for water quality (Table 1). Fig. 1 shows the growth performance of the juvenile mullets. The mean weight of fish that were fed increased from  $7.25 \pm 0.10$  to  $41.85 \pm 1.06$  g (476.7% increment), while those that were not fed increased from  $7.17 \pm 0.38$  to  $32.10 \pm 44$  g (347.7% increment). Growth within the first 150 days was similar in both treatments, but after the 150th day higher growth was recorded for

fish that received feed. The difference in growth performance between treatments in both experiments was not significant ( $P > 0.05$ ).

The mean daily weight gain, specific growth rate of fish, and production of ponds in which feed was supplied were, respectively, higher (0.1281 g/day; 0.6500 %/day; 336.5 kg/ha) than those in which feed was not supplied (0.0923 g/day; 0.5557 %/day; 287 kg/ha) (Table 2). The average feed conversion ratio was 7.4, suggesting inefficient use of feed by fish. The

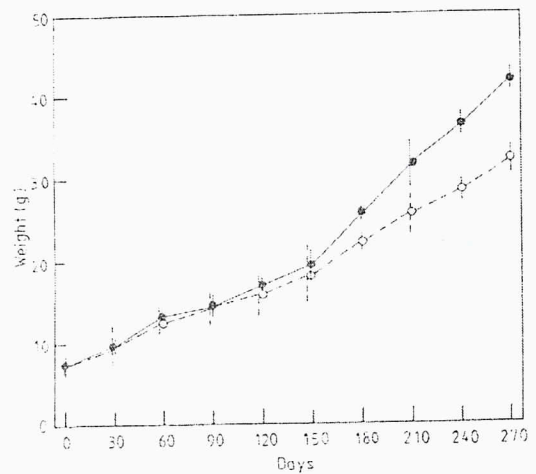


Fig. 1. Growth performance of grey mullet species in brackish water ponds (solid line—feed provided, broken line—no feed provided; vertical bars =  $\pm 1$  SD).

TABLE I  
Mean values of water quality parameters in brackish water ponds during the 270-day culture period

Water quality parameter	Ponds with feed	Ponds without feed	t-value
pH	$7.77 \pm 0.45$	$7.90 \pm 0.61$	0.543716
Temperature ( $^{\circ}\text{C}$ )	$30.15 \pm 1.36$	$30.15 \pm 1.35$	0.431249
Dissolved oxygen ( $\text{mg l}^{-1}$ )	$8.07 \pm 1.53$	$7.97 \pm 1.67$	0.146334
Salinity ( $\text{‰}$ )	$1.95 \pm 0.78$	$2.03 \pm 1.09$	0.193785
Transparency (cm)	$19.25 \pm 5.0$	$17.08 \pm 4.32$	1.002133
Turbidity (NTU)	$42.0 \pm 15.7$	$46.56 \pm 12.94$	0.594482

TABLE 2  
Mean daily weight gain, survival rate, production, and feed conversion ratio of grey mullets cultured in brackish water ponds

Pond	No. of days	No. of fingerlings (n)	Mean weight gain/day (g)	Specific growth rate (%/day)	Survival (%)	Production (kg ha <sup>-1</sup> )	Feed conversion ratio
1 (no feed)	270	152	0.0948	0.5702	51.88	266	N/A
2 (no feed)	270	124	0.0936	0.5411	68.67	347	N/A
3 ( feed)	270	160	0.1306	0.6550	43.42	306	7.1
4 ( feed)	270	152	0.1256	0.6449	54.17	367	7.7

\*N/A – not applicable

survival rate of fish in ponds supplied with supplementary feed was lower (48.5 %) than those without supplementary feed (60.3 %). More and bigger predators were found in the former ponds than in the latter. On the whole, the average survival in all the ponds was 54.5 per cent.

At the end of the experiment, *Mugil curema* (Valenciennes) and *M. bananensis* (Pellegrin) were found to be the most common species in the ponds. Comparatively, higher final mean weights were recorded for *M. curema* and *M. bananensis* than for the other species of mullets in all the ponds. The final mean weights of *M. curema* and *M. bananensis* in ponds that received feed were  $49.50 \pm 1.34$  g and  $41.80 \pm 1.60$  g, while those of *Liza dumerilii* (Steindachner) and *Liza*

*falcipinnis* (Valenciennes) were  $42.64 \pm 2.54$  g and  $34.1 \pm 2.15$  g, respectively. For ponds that did not receive feed, the final mean weights of the various species were *M. curema*,  $37.38 \pm 4.41$  g; *M. bananensis*,  $31.45 \pm 2.59$  g; *L. dumerilii*,  $28.50 \pm 2.28$  g; and *L. falcipinnis*,  $22.89 \pm 1.89$  g.

#### Culture trials in fresh water ponds

Just as in the brackish water ponds, the difference in the water quality of fresh water ponds that received feed and those that did not receive feed was not significant (Table 3). After the 180-day culture period, the mean weight recorded for fish that were fed ( $28.65 \pm 0.78$  g) was higher than those that were not fed ( $25.56 \pm 0.34$  g). The initial weights were  $8.34 \pm 1.21$  g and

TABLE 3  
Mean values of water quality parameters in fresh water ponds used for culture of mullets during 180-day culture period

Water quality parameter	Ponds with feed	Ponds without feed	t-value
pH	$7.51 \pm 0.80$	$7.64 \pm 1.08$	0.690610
Temperature (°C)	$28.75 \pm 0.87$	$29.19 \pm 1.27$	0.744302
Dissolved oxygen (mg l <sup>-1</sup> )	$6.10 \pm 3.49$	$5.27 \pm 2.98$	0.437190
Transparency (cm)	$18.83 \pm 7.02$	$19.13 \pm 6.91$	0.068164

7.82 ± 0.88 g for the former and latter, respectively (Fig. 2). Thus, an increase of 243.5 per cent was recorded for fish that received supplementary feed, and 226.8 per cent for those that did not receive supplementary feed. The difference in growth performance between treatments in the fresh water ponds was, however, not significant ( $P > 0.5$ ). Production and survival rates could not be calculated as a result of premature termination of the experiment after 180 days owing to

predation.

As recorded in the brackish water ponds, the average mean daily weight gain and specific growth rate were higher for fish that were fed (0.1128 g/day: 0.6856 %/day) than for those that were not fed (0.0986 g/day: 0.6579 %/day) (Table 4). The feed conversion ratios in Ponds 3 and 4 that were supplied with feed were 6.2 and 7.2, respectively, giving a mean value of 6.7. Considering the same culture period of 180 days, the difference in growth performance between fish raised in fresh and brackish water ponds was not significant ( $P > 0.05$ ) (Table 5).

## Discussion

### Survival

Mortalities observed during transportation were between 6 and 10 per cent, higher than the 2 per cent reported by Bok (1984). This was attributed to physical damage incurred during collection. Most fishes that died during transportation and acclimatisation, and those which died later after introduction into ponds in the study were observed to have lesions on their skin. Grey mullets are known to be fragile species that lose their scales very easily even when touched with the hand. It is most likely that lost scales make them more prone to bacterial and fungal infections that could cause mortalities even several days after stocking. Yashouv (1972) concluded that

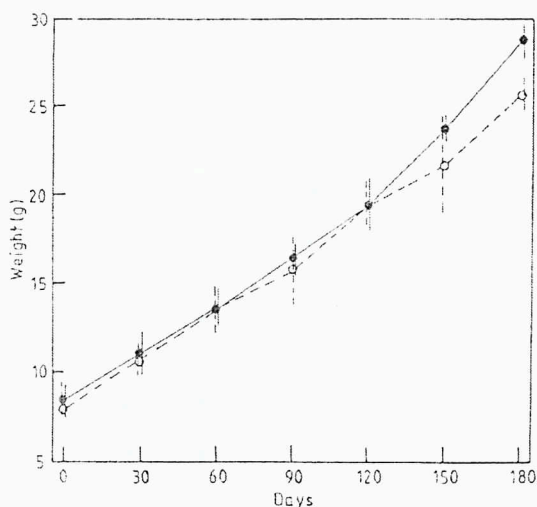


Fig. 2. Growth performance of grey mullet species in fresh water ponds (solid line—feed provided, broken line—no feed provided; vertical bars = ± 1SD).

TABLE 4

Mean daily weight gain, specific growth rate, and feed conversion ratio of grey mullets cultured in fresh water ponds

Pond	No. of days	No. of fish stocked	Mean weight gain/day (g)	Specific growth rate (%/day)	Feed conversion ratio
1 (no feed)	180	100	0.0973	0.6314	N/A
2 (no feed)	180	100	0.1000	0.6894	N/A
3 (feed)	180	100	0.1147	0.7368	6.2
4 (feed)	180	100	0.1221	0.6404	7.2

\*N/A – not applicable

TABLE 5  
Comparison of mean daily weight gain (MDWG), specific growth rate (SGR), percentage weight increment, and feed conversion ratio of fish raised in brackish and fresh water ponds for 180 days

Culture type	MDWG (g/day)		SGR (%/day)		Percentage weight increment (%)		Feed conversion ratio
	Feed	No feed	Feed	No feed	Feed	No feed	
Fresh water	0.1128	0.0986	0.6856	0.6580	243.5	226.9	6.0
Brackish water	0.1025	0.0841	0.7030	0.6304	254.5	211.0	5.9

the basic factor in mullet survival in fishponds is their treatment and handling at the time of stocking or when transferred from pond to pond.

Apart from injuries, other factors that might have affected survival were temperature, salinity and pH. Both *L. falcipinnis* and *M. curema* have survived transfer from 32.5‰ to fresh water with no mortality (Williams, 1962; quoted in Payne, 1976). Salinity in the Volta estuary where juvenile mullets were collected did not exceed 10 per cent at the time of collection. In spite of this low salinity, immediate transfer of mullets from brackish water into fresh water resulted in almost 80 per cent mortality even when temperature and pH were virtually similar to those of the receiving ponds. It was, therefore, necessary to acclimatise the fish for over a week before transferring them to fresh water ponds. It is possible that other water quality parameters, possibly pH, as indicated by Sivalingam (1975), could be equally critical for survival. In this study, mullets became stressful whenever pH dropped below 6 in ponds; in such situations, lime was applied to raise the level to between 7 and 8. Temperatures between 26 and 28 °C were observed to be suitable during transportation of juveniles.

The average survival of 54.5 per cent from all the ponds compares favourably with what has been reported by Bok (1984). Survival rates of 62 to 100 per cent were reported for *M. cephalus* stocked at a size of 30 g (Yashouv, 1972), while survival rates of between 50 and 85 per cent were

reported by Linder *et al.* (1975) for the same species stocked at a much smaller size of between 0.37 and 4.81 g. Mortalities were attributed to handling and predation by birds and crabs. In this study, apart from handling, mortalities also occurred as a result of predation by fish, frogs and monitor lizards.

#### *Growth and production in ponds*

The similarity in growth pattern of fish in ponds supplied with supplementary feed and those in ponds without supplementary feed during the first few months of the experiment could be due to adequate and ready availability of natural food. With time, food could become inadequate if replenishment, through fertilisation, was not fast enough. The addition of supplementary feed could enhance the growth of fish receiving such treatment; hence, the divergence in growth pattern after a certain culture period, with those receiving feed growing faster.

Species that were found in the brackish water ponds at the end of the experiment were *L. falcipinnis*, *L. dumerilii*, *M. curema*, and *M. bananensis*. Conspicuously missing was *M. cephalus*, the species known to be the fastest growing among the mullet species (Bardach *et al.*, 1972; Pruginin, Shilo & Mires, 1975; Linder *et al.*, 1975; Alves de Araujo, Rawanathan & Chellapa, 1980; Bok, 1984). This characteristic has made it an obvious choice for culture in most places. From the monthly sampling in the River

Volta and River Pra estuaries, it became evident that *M. cephalus* indeed grows bigger than the other species, but was the least common. Getting their fingerlings from the wild for culture will, therefore, be difficult. In the absence of *M. cephalus*, the highest mean weight was registered for *M. curema*, followed by *M. bananensis*.

Apart from *M. cephalus*, the other mullet species have, however, been shown to have great culture potential. Production of 239 kg ha<sup>-1</sup> yr<sup>-1</sup> was recorded without any supplementary feeding in polyculture trials conducted in brackish water ponds in Lagos, Nigeria (Sivalingam, 1975). From Rio Grand do Norte (Brazil), Alves de Arajo *et al.* (1980) have reported production of 276 kg ha<sup>-1</sup> for *M. curema* after one year of culture in brackish water ponds, also without supplementary feed and fertilisation. Net mullet productions of 217.74 and 209.76 kg ha<sup>-1</sup> yr<sup>-1</sup> have been reported by Pakrasi, Basu & Banerjee (1975), while Linder *et al.* (1975) reported production between 293 and 804 kg ha<sup>-1</sup> for striped mullet from Texas, USA.

In this study, where mixed species of grey mullets were cultured for 270 days, production of 336.5 kg ha<sup>-1</sup> (454.24 kg ha<sup>-1</sup> yr<sup>-1</sup>) and 287 kg ha<sup>-1</sup> (388.0 kg ha<sup>-1</sup> yr<sup>-1</sup>) were recorded in ponds with and without supplementary feed, respectively. These results compare favourably with those of previous studies, although production levels for those studies were considered to be low (Sivalingam, 1975; Pakrasi *et al.*, 1975; Linder *et al.*, 1975). Production from ponds that were supplied with feed was comparatively higher and confirms the assertion by Sivalingam (1975) that addition of supplementary feed increased yield and average size of fish.

The low production in this study is reflected in the low daily growth gain, specific growth rates, and feed conversion ratios. The daily growth gain ranged from 0.1128 to 0.1568 g/fish/day for fish supplied with feed, and from 0.0923 to 0.1375 g/fish/day for fish that were not fed. The specific growth rate ranged from 0.6493 to 1.1521 per cent per day for fish supplied with feed, and from

0.5552 to 1.1368 per cent per day for fish without feed. These are low compared to other results reported for some species of grey mullets. For example, golden grey mullet (*Liza aurata*) raised in salt water for 150 days attained growth rate of 0.95 g/fish/day (Chervinski, 1975). Growth rate of between 0.6 and 0.95 g/fish/day was recorded for *L. aurata* during the 1st year of culture, and between 0.85 and 1.0 g/fish/day was recorded in the 2nd year (Chervinski, 1976). The daily growth rates recorded for *M. cephalus*, *Liza parvus* and *Liza tade* during a culture period of 374 days, together with carps, milkfishes and prawns in a low saline pond, were 1.313, 0.069, and 0.298 g, respectively (Pillai *et al.*, 1984). Linder *et al.* (1975) reported mean daily weight of between 0.36 and 0.71 g from the six ponds they used for *M. cephalus*.

The low production reported by Sivalingam (1975) and Alves de Araujo *et al.* (1980) was attributed to the experiment being conducted without supplementary feed and fertilizers, as well as to predators. Apart from the predators met in this study, *Sarotherodon melanotheron* and *Oreochromis niloticus* might have competed with the grey mullets for the same food resources and space, thereby inhibiting their growth. These herbivorous fishes were introduced into the ponds as a result of periodic pumping of water to maintain a constant level of water in the ponds.

Yashou (1972) argued that higher fish density, especially considering the tendency of mullets to school, has a depressing effect on growth. He also asserted that the growth of grey mullets seems to be influenced by its competition for food with other fish groups in ponds. Coupled with this is the fact that in this study, feed supplied might also not have been easily available to the fish owing to wind action. It was, therefore, possible that the supplementary feed was grossly underused. This is confirmed by the feed conversion ratio of about 7.0, which was rather high compared to the range of 2.24 to 3.31 reported for *M. cephalus* (Linder *et al.*, 1975).

Apart from density, which might have caused

competition, the length of the growing season with respect to initial size of fish stocked was cited by Yashouv (1972) as one of the factors that could have affected growth of grey mullets. He noted that as the growing period is increased, or the larger the fish are allowed to grow, the higher the increase in daily yield. According to Hopkins (1992), small and large fish have low absolute growth rates while fish of intermediate sizes have higher absolute growth rates. Thus, differences in initial stocking size and length of culture period could affect growth and make comparison with other studies more difficult. If survival rates could be minimised, perhaps, it will be advisable to use juveniles of bigger size (e.g., 20 g) as initial stocking material for better yields.

According to Hora & Nair (1944) (quoted in Pillai *et al.*, 1984), mullets grow faster in fresh waters. Considering the same culture period, the mean daily weight gain, specific growth rate, percentage growth increment, and feed conversion ratio of fish raised in brackish water ponds were quite similar to those raised in fresh water ponds. The fresh water ponds remained mostly turbid during the culture period. As a result, plankton production was observed to be very low irrespective of fertilization. The poor growth performance of mullets in fresh water ponds may also be attributed to low concentration of natural food. Pillai *et al.* (1984) assigned similar reason for the slow growth of mullet species they cultured in a coastal low saline polyculture pond in West Bengal, although the fish were given supplementary feed. The turbid nature of the fresh water ponds could have adversely affected the chances of fish to detect supplementary feed supplied; hence, the poor use of feed in such ponds.

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